
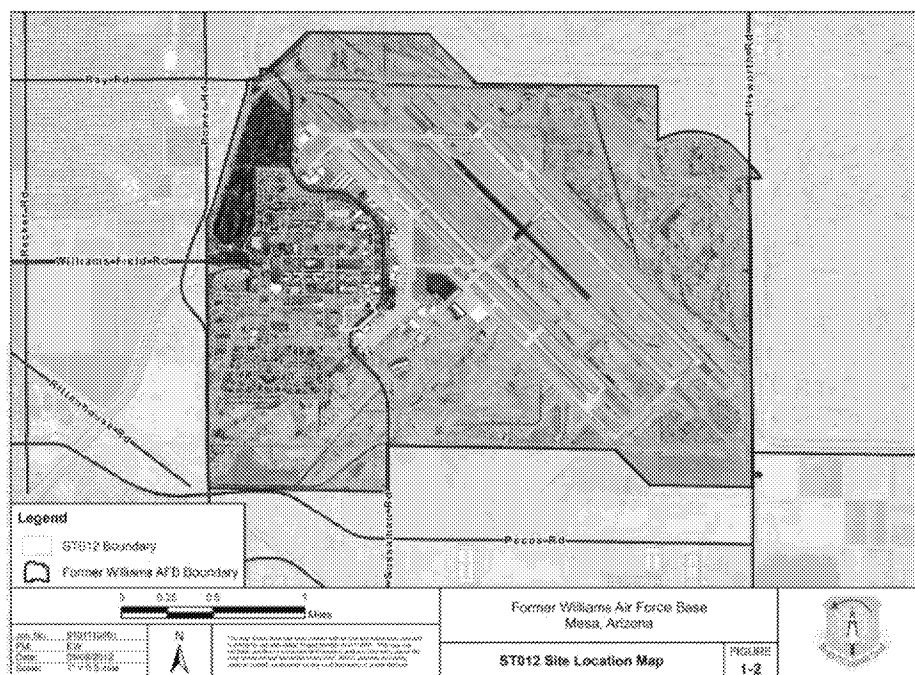


**Williams AFB
ST12 Fuels Spill Site
Need for Continued Post
SEE Extraction**

 **EPA** United States
Environmental Protection
Agency

24th Annual NARPM Training Program

Williams Air Force Base/ ST12 location



United States
Environmental Protection
Agency

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Initial Site Characteristics

- ◆ Fuel LNAPL extent to depth of ~ 240 feet bgs
- ◆ Water table has risen to ~ 150 ft bgs, trapping LNAPL below the water table below Low Permeability Zone (LPZ)
- ◆ Water table rising 1 - 5 ft/yr – now within high permeability cobble zone
- ◆ LNAPL – contaminated area below water table is ~ 450,000 yd³
- ◆ Dissolved phase plume
- ◆ 3 hydrogeologic units: Lower Saturated Zone (LSZ);
Upper Water Bearing Zone (UWBZ); Cobble Zone (CZ)

[illegible]

Figure 1: Conceptual Site Model of HAPs Containment After Waste Trade Ban

The figure consists of several parts:

- Main Cross-Section Diagram:** A detailed cross-section of the site showing the ground surface, water level, and various geological zones. The zones are labeled as Coarse Zone, Upper Water Bearing Zone, Low Permeability Zone, Lower Water Bearing Zone, and Aquifer. The diagram also shows the extent of the pool impacted soil and the location of HAPs (Highly Active Polymers) within the site.
- KEY:** A legend for the symbols used in the diagram, including:
 - Ground Surface
 - Water Level 2010
 - Crack/Impervious Seepage
 - Coarse Zone
 - SBs & Clay
 - HAPs Free Product
 - HAPs at Sealed Containment
 - Observed Phase
 - Characterized Soil
- KEY MAP:** A map showing the location of the site within a larger geographical context, including a north arrow and a scale bar.
- Table:** A table providing additional information about the site, including:
 - Table 1: HAPs Containment After Waste Trade Ban**
 - Table 2: HAPs Containment After Waste Trade Ban**
 - Table 3: HAPs Containment After Waste Trade Ban**

The figure is a complex technical drawing that provides a detailed view of the site's geology and the location of HAPs. It is a key component of the site assessment and is used to inform decision-making regarding the site's future use and management.

TEE Pilot Completed in 2011

- ◆ Pilot test conducted in single cell in center of most contaminated area
- ◆ Post steam sampling found LNAPL expansion outside treatment area.

Possible causes:

- a. Pump failures
 - b. Water table rising into more permeable / transmissive cobble zone
 - c. Water table rise into vadose zone contamination
- ◆ AF continued extraction after pilot test to prevent spread of plume until it could be addressed by full scale SEE

Full Scale Steam Remedy

- ◆ Performance based contract to complete SEE remedy awarded to Amec in 2012
- ◆ Focused FS and RODA selecting steam signed Sept 2013
- ◆ RD Workplan – draft: Oct 2013; Final: June 2014
- ◆ Well Abandonment/ Construction/Development: Nov 2013- May 2014
- ◆ Piping/Utilities/Boiler installation: April – June 2014
- ◆ Begin Groundwater Extraction – September 29, 2014
- ◆ Begin Steam Injection –October 14, 2014

System was designed and constructed in advance of final RD/RA workplan approvals; Amec didn't address all agency concerns.

Current Concern

- ◆ Steam injection ceased on March 4, 2016 while significant NAPL still being recovered
- ◆ SEE extraction sytem was shut down on April 29, 2016

Containment Issues

- ◆ Hydraulic containment concerns have been raised throughout the SEE Operations; still not addressed through characterization
- ◆ Amec is proceeding with EBR proposal without characterizing to confirm remaining mass or spread of plume – how then to evaluate success of EBR?
- ◆ Site is still hot and contaminants more mobile
- ◆ EBR to use Sodium Sulfate to promote anerobic biodegradation which has lower degradation rate

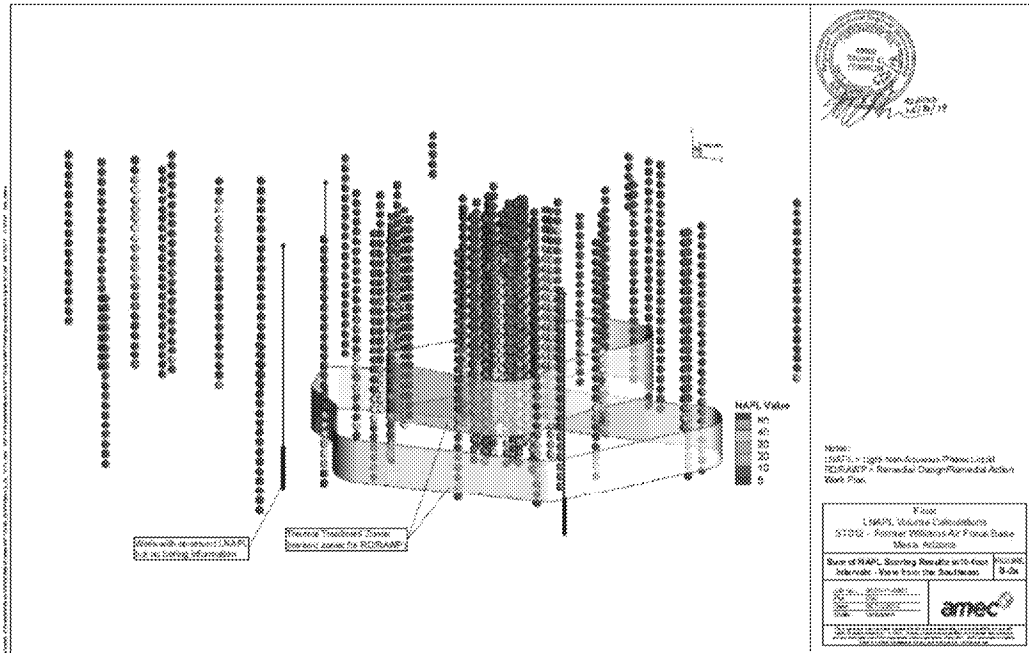


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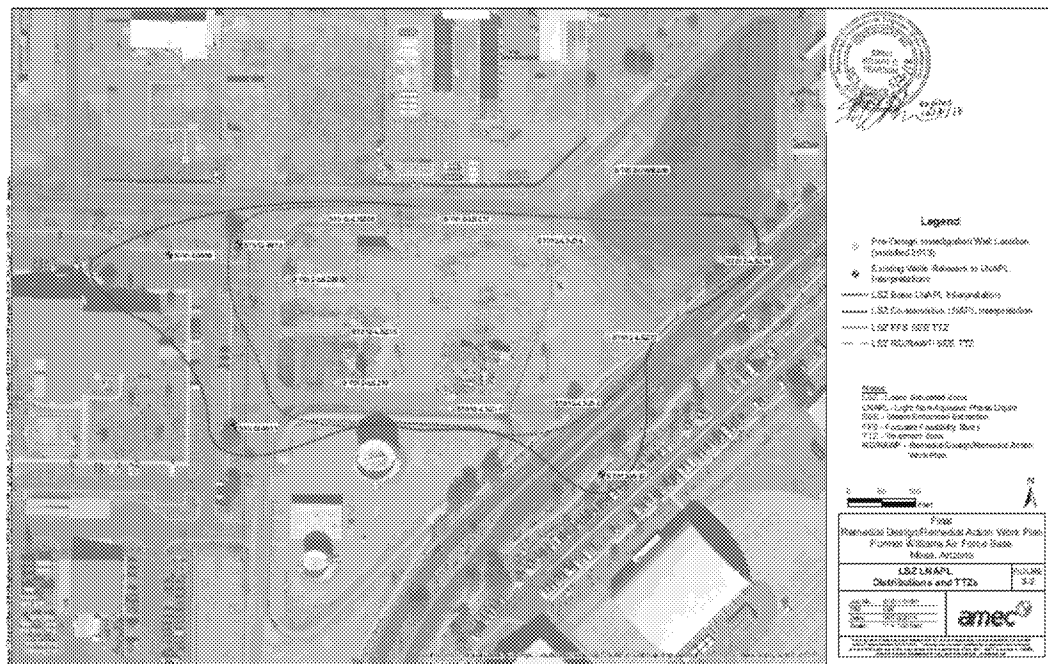
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LNAPL Reconnaissance view from southeast) LNAPL extends beyond SEE treatment area



Interpretative LNAPL Distribution in LSZ

Amec extended SEE treatment area as far as practical in LSZ



Solid Blue - Estimate from feasibility study and original PBR contract budget estimate

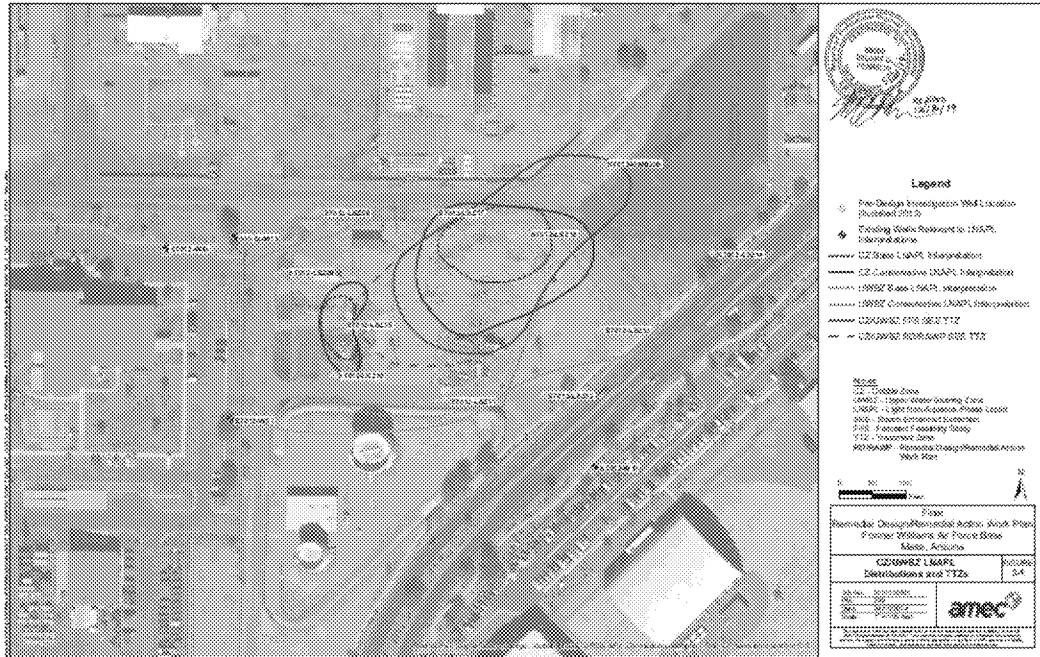
Dashed Blue - Expansion of TTS during Remedial Design; limited by roadway and surrounding building and structures

Dashed Pink - Base case estimated NAPL extent

Solid Pink - Conservative estimate

Interpretative LNAPL Distribution in UBWZ/CZ

Amec chose not to extent SEE treatment boundary, as we requested



Red - interpretive base case CZ LNAPL extent (dashed) conservative case (solid)
 Green interpretive base case UWBZ LNAPL extent (dashed) conservative solid
 Blue - UWBZ/CZ TTZ : solid

Conceptual model of Pre SEE LNAPL distribution (view from southeast)

Base Case

Conservative Case

12

12

Legend

- [illegible]

6009, 60225, 60296, 60346, 60357 ON 6035720
6035721 6035722, 6035723 ON 6035723



13

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[illegible]

Interpretive Mass Removal - CZ

Legend

- REMEDIATION MONITORING WELL
- OBS. 05 - 0
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- OBS. 03 - 1
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- OBS. 100 - 1

BEFORE

AFTER

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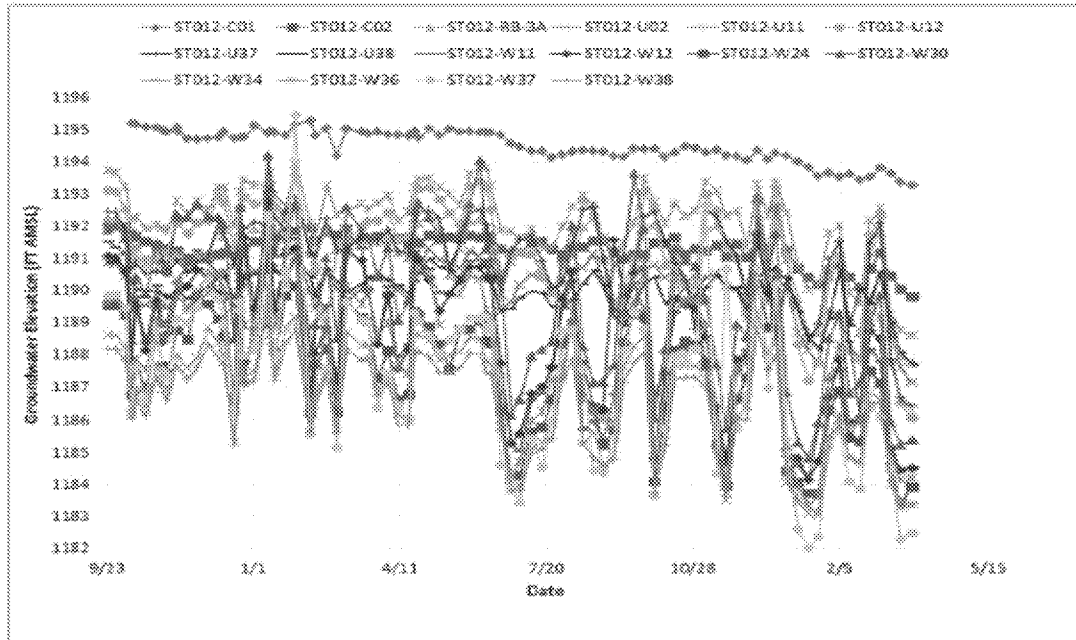
15

Estimate of Remaining LNAPL from current EBR workplan

Conservative LNAPL Interpretation

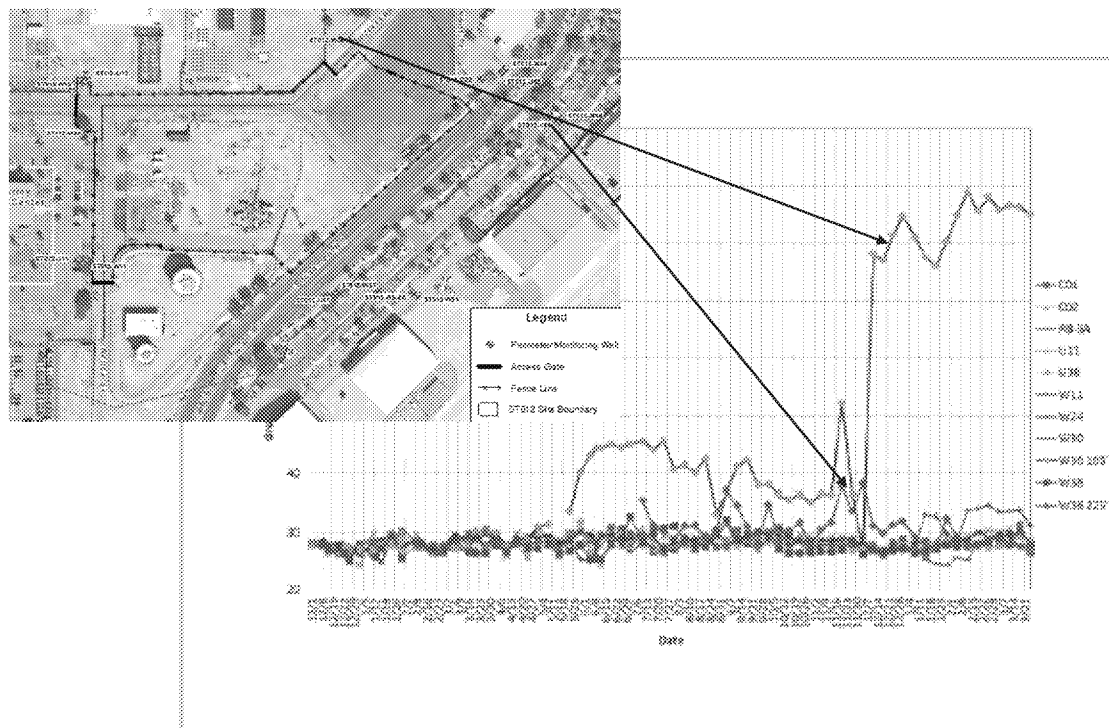
	TTF	EBR Treatment Area Volume		Treatment Area Volume		Total Residual Volume	
		Calculated Volume of	Volume of LNAPL	Calculated Volume of	Volume of LNAPL	Volume of LNAPL	Volume of LNAPL
Cobble Zone	cu ft	848	887	2,087	1,436	2,855	2,043
	gallons	6,343	4,538	15,014	10,743	21,357	15,282
	LNAPL Removed (gallons)	0	0	0	0	0	0
	Remaining LNAPL (gallons)	6,343	4,538	15,014	10,743	21,357	15,282
	Uncertainty Factor	50%	50%	75%	75%	75%	75%
Upper Water Bearing Zone	Lower Range (gallons)	3,171	3,268	11,251	8,057	16,018	11,451
	cu ft	23,459	24,625	31,587	33,167	55,057	57,792
	gallons	175,475	184,192	235,348	245,089	411,834	432,281
	LNAPL Removed (gallons)	0	0	0	0	0	0
	Remaining LNAPL (gallons)	175,475	184,192	235,348	245,089	411,834	432,281
Low Permeability Zone	Uncertainty Factor	50%	50%	75%	75%	75%	75%
	Lower Range (gallons)	87,738	92,096	159,711	175,515	301,317	316,660
	cu ft	7,417	7,337	15,661	15,490	33,078	32,827
	gallons	55,481	54,877	117,144	115,868	172,635	170,746
	LNAPL Removed (gallons)	0	0	0	0	0	0
Lower Saturated Zone	Remaining LNAPL (gallons)	55,481	54,877	117,144	115,868	172,635	170,746
	Uncertainty Factor	50%	50%	75%	75%	75%	75%
	Lower Range (gallons)	27,741	27,439	87,858	86,901	129,469	128,059
	cu ft	13,788	10,654	40,755	37,723	53,553	42,877
	gallons	95,652	229,395	304,926	730,966	400,577	960,261
	LNAPL Removed (gallons)	0	0	0	0	0	0
	Remaining LNAPL (gallons)	95,652	229,395	304,926	730,966	400,577	960,261
	Uncertainty Factor	50%	50%	75%	75%	75%	75%
	Lower Range (gallons)	47,826	114,648	210,129	529,760	261,948	701,731

Perimeter groundwater elevations response to injection/extraction



Containment of contaminants has been a major concern throughout SEE operations

Perimeter Well Temp Data Over Time



High temp water is migrating downgradient – may spread hydrocarbon plume

Extra slides

Full Scale SEE Operation

- ◆ 34 Injection/Extraction Wells 80 -100 feet apart:
Injection: 6-cobble zone 10-UWBZ 18-LS
Extraction: 14-cobble zone 14- UWBZ 27-LSZ
Dual Purpose: UWBZ- 2
- ◆ Groundwater Extraction began on September 29, 2014
- ◆ Steam Injection Began October 14, 2014
- ◆ Originally anticipated to run approximately 422 days through November 2015.
- ◆ Enhanced Bioremediation to Follow Steam Shutdown.

Operational Status as of 3/30/16

- ◆ Total Vapor and Liquid Mass Removal: **2,513,587 lbs** hydrocarbons
- ◆ Total Removed as NAPL: **1,374,207 lbs / 209,164 gals** reusable fuel
- ◆ Average Daily NAPL Mass Removal Last Week **1,538 lbs/day**
- ◆ Days of Operation: **546 days** (129 % of estimate)
- ◆ Total Steam Injection **320 million lbs** (94% of estimate)
- ◆ Total Energy Used **5,666,173 kWh** (50% of estimate)
- ◆ Total Water Extracted **89,258,784 gallons**
- ◆ Total Treated Water Discharge **118,237,000 gallons**

Benzene in LSZ Groundwater After SEE

Annual Groundwater Monitoring Report (Nov 2014)

LSZ Pre-SEE

Legend:

Benzene Concentrations (µg/L) in Groundwater (Dashed Where Interpolated)

- 5-999 µg/L (C₁-2 ROD Assessment 2 Cleanup Level is 5 µg/L)
- 1,000-9,999 µg/L
- ≥ 10,000 µg/L

Other Symbols:

- Groundwater Monitoring Well Location
- Subsidence Detection Well Location
- Range Unit
- Site Boundary

Site Boundary

LSZ Nov 2014 Sampling Event

Benzene Concentrations (µg/L) in Groundwater (Dashed Where Interpolated)

- 5-999 µg/L (C₁-2 ROD Assessment 2 Cleanup Level is 5 µg/L)
- 1,000-9,999 µg/L
- ≥ 10,000 µg/L

Other Symbols:

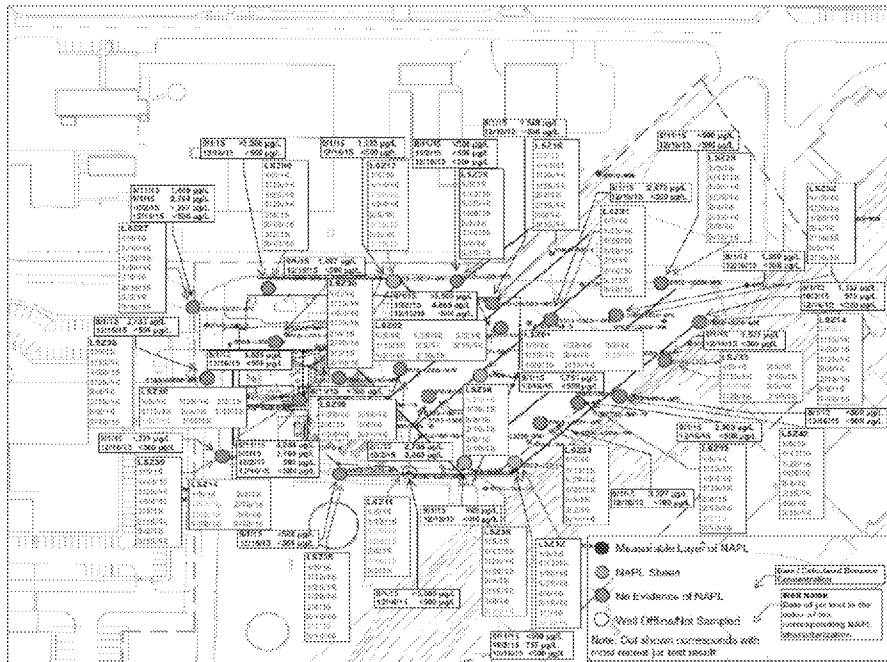
- Groundwater Monitoring Well Location
- Subsidence Detection Well Location
- Range Unit
- Site Boundary

Site Boundary

22

22

NAPL Jar Test Screening/Calculated Benzene LSZ (November 2015 –March 2016)

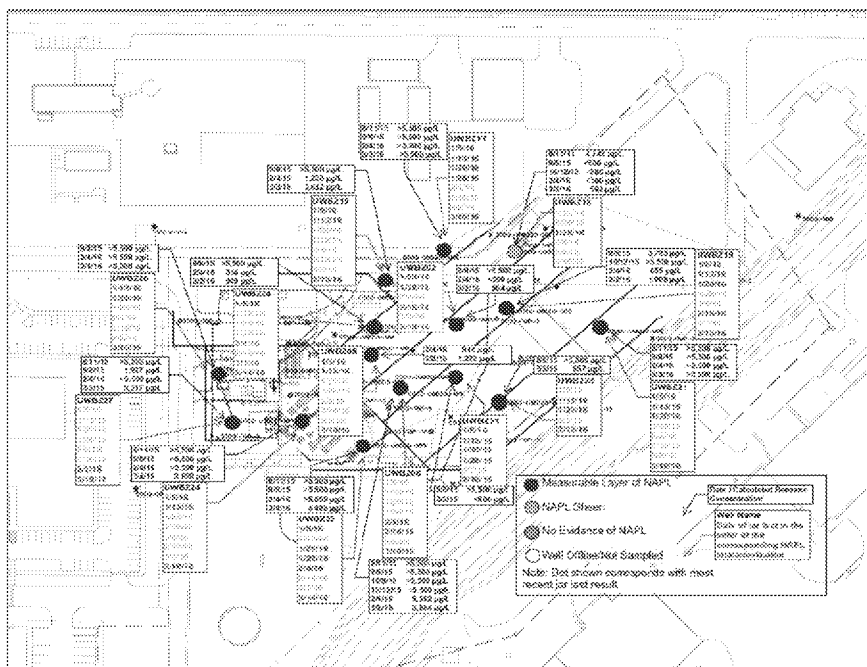


Results as of
3/14/16

2 weeks after last
pressurization
cycle completed
on 3/4/16

Jar samples collected from biweekly from wells beginning in November 2015 to look for evidence of NAPL, latest results shown. Green = no evidence of NAPL Yellow = NAPL Sheen Red= measurable layer of NAPL present LSZ had the most NAPL initially, also received the most steam treatment , larger area longer time, also greater pressure with depth. Results shown as of March 14 Weekly Progress Report, After last pressurization cycle ending on March 4

NAPL Jar Test Screening/Calculated Benzene UWBZ (November 2015 –March 2016)



Results as of
3/14/16

2 weeks after last
pressurization
cycle completed
on 3/4/16



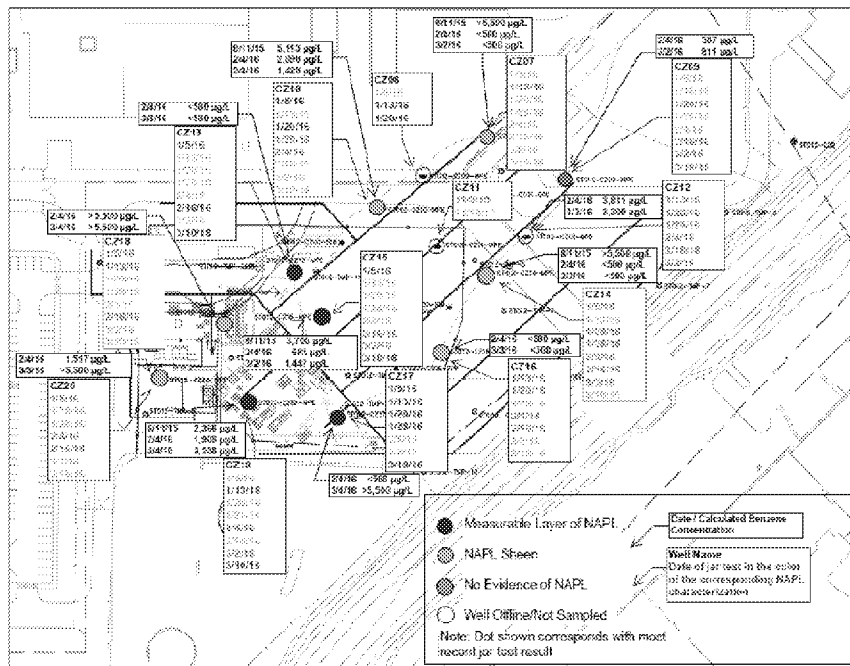
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After last depressurization ending March 4, NAPL measured in almost all the UWBZ wells

NAPL Jar Test Screening/Calculated Benzene CZ (November 2015 –March 2016)

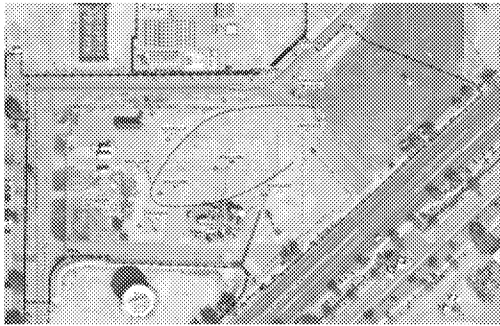


Results as of
3/14/16

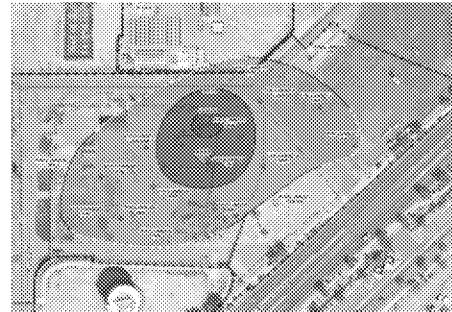
2 weeks after last
pressurization
cycle completed
on 3/4/16

Benzene in Groundwater Pre-SEE (2014)

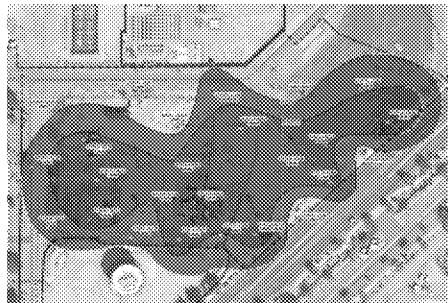
Cobble Zone (CZ)



Upper Water Bearing Zone (UWBZ)



Lower Saturated Zone (LSZ)



Legend

Benzene Concentrations (µg/L) in Groundwater
(Concentrations Where Indicated)

500-999 µg/L

>1000 µg/L

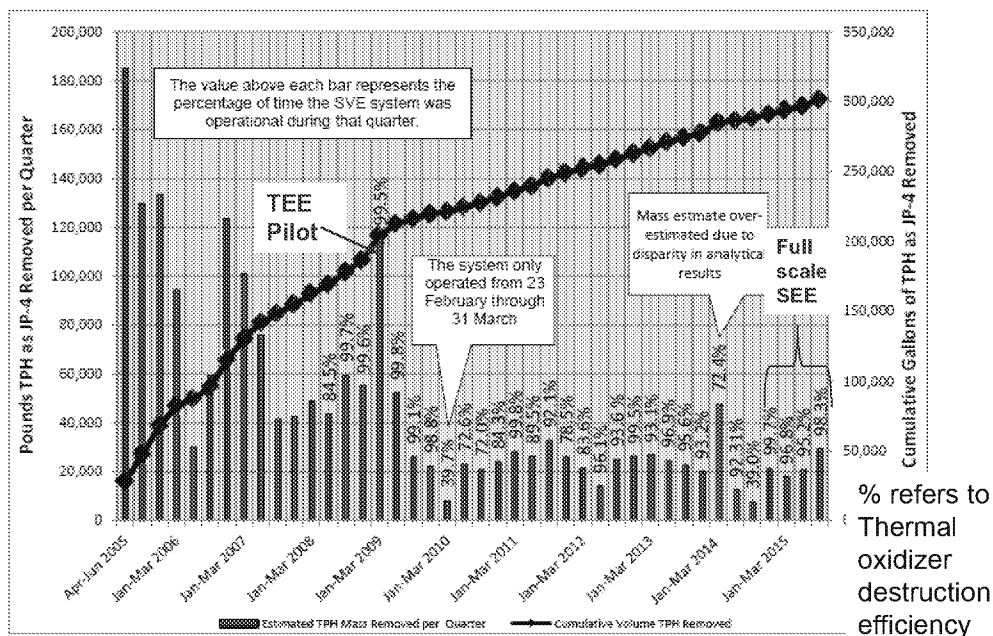
Steam Injection Well Location

Multi-Phase Extraction Well Location

Fence Line

07012 Site Boundary

SVE Historical Mass Removal TPH as JP4

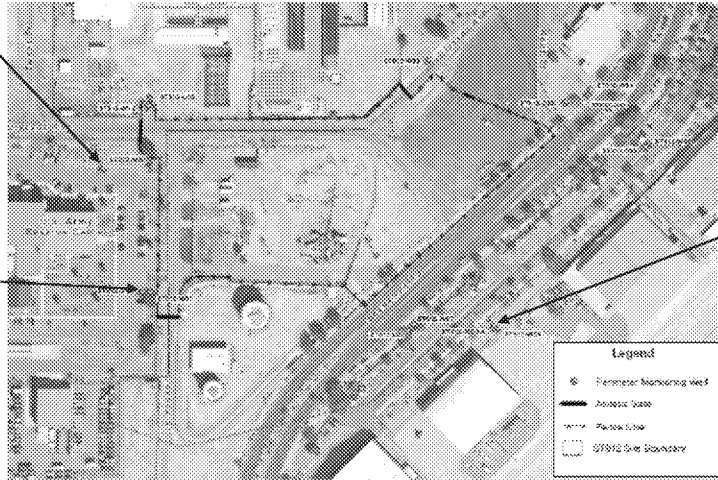


Most mass removed from SVE in early years, and declining, with a significant increase during operation of the TEE pilot, after that significant drop off in mass recovery. We are not seeing any increase in SVE recovery rate during operation of full scale SEE, which may indicate most of the recoverable mass has been removed

Passive LNAPL Removal in Exterior Wells W11, W30 and W37

W30
30.8 gals
mobilized
LNAPL
removed
as of
3/11/16

W11
1071.2
gallons
mobilized
LNAPL
removed as
of 3/11/16



W37
2892.98
gallons
mobilized
LNAPL
removed
as of
3/11/16

About 4000 gallons LNAPL passively removed from 3 perimeter wells